JPL/NASA and Internet2 (I2) Abilene–Backbone Network Connectivity

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Phases of Network Design:

1. Technology Trial
2. Alpha Test
3. Beta Test
4. Full Production

1. Technology Trial

User and Designer are learning from each other.

Network downtime and reconfiguration are expected often.

Network services are limited in scope and functionality.

Mission critical users are not advised at this stage.

2. Alpha Test

H/W is fully operational.
Operation is buggy.
Few users are are on the network.
Users should not be impacted by downtime.

4. Full Production

Network is running with full functionality.

No downtime(unless scheduled in advance).

All bugs(known) had been eliminated.

Network is now transparent to the average user.

Users should feel they have full connectivity: when required, with required bandwidth, to every destination they communicate with.

3. Beta Test

- Final test before commercial or public availability
- Users should experience little or no down time
- Most of the bugs should be out of the system

What is Internet2?

A non-profit research & development consortium being led by over 225 U.S. universities working with corporate members

Began in October, 1996, by 34 research universities

A major development program for advanced network applications & technologies.

The creation of tomorrow's Internet

Internet2(I2) consists of:

-**Abilene** High Performance Backbone Network.

-A number of working groups for the development of Middleware (set of standards, interfaces, and services) & new applications

Internet2(I2) Working Groups Include:

1. IPv6
2. Measurements
3. Multicast
4. Network Management
5. Quality of Service (QoS)
6. Routing
7. Security
8. Topology
9. Digital Video
10. Digital Imaging
11. Video Conferencing
12. VoIP
13. Network Storage

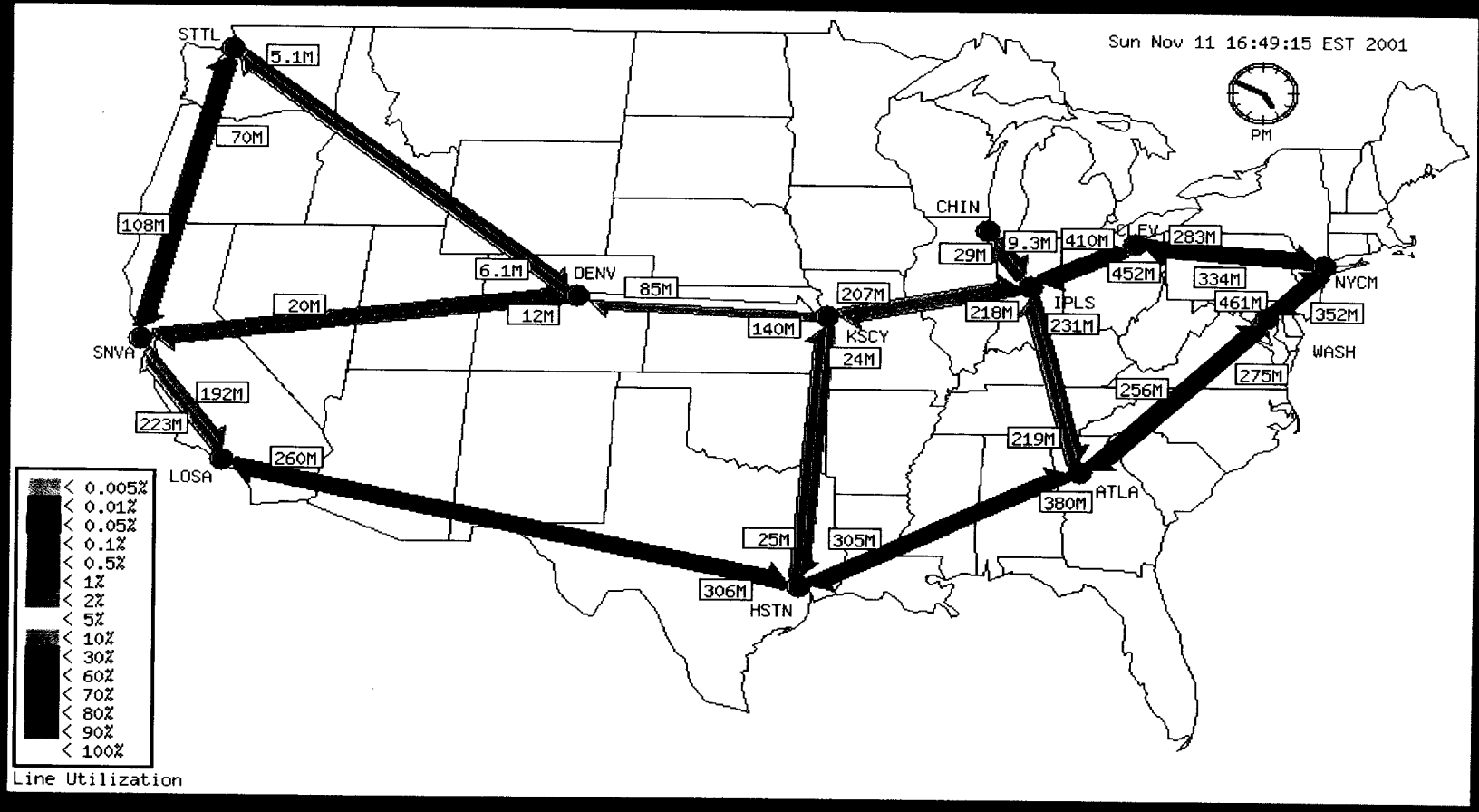
Abilene

NETWORK

The Abilene core node connections are:

- Seattle to Sunnyvale
- Seattle to Denver
- Sunnyvale to Los Angeles
- Sunnyvale to Denver
- Los Angeles to Houston
- Denver to Kansas City
- Kansas City to Houston
- Kansas City to Indianapolis
- Houston to Atlanta
- Indianapolis to Atlanta
- Indianapolis to Cleveland
- Atlanta to Washington D.C.
- Cleveland to New York
- Washington D.C. to New York

Abilene Backbone



- Abilene network runs on over10, 000 miles of national backbone.
- Operating at 2.4 Gbps (OC48) among GigaPoPs. Connections to Abilene are at 155 Mbps(OC3); 622 Mbps(OC12); and 2.4 Gbps(OC 48).
- Abilene uses packet/IP over SONET.
- Availability~99.999,
- RTT~55ms(commodity~155ms)
- Loss~1%
- Abilene runs~(10-15)% of full capacity.

Abilene connects with the following Networks

(NGI)

1. U.S. Department of Energy's Energy Sciences Network (ESnet).
2. NASA Research and Education Network (NREN).
3. NASA Integrated Services Network (NISN).
4. Defense Research and Engineering Network (DREN).

5. Defense Advance Research Projects Agency (DARPA) SuperNet.

6. Very High Speed Backbone Network Service (Vbns).

7. California Research and Education Network (CalREN-2)

Purpose

Abilene Project was started by UCAID (University Corporation for Advanced Internet Development) to be a research network for advanced Internet technologies and applications. Their main focus is on QoS, Multicasting, and IPv6 implementation.

Abilene Characteristics

IP – SONET

OC – 3 (155Mbps) to OC-48 (2.45Gbps),

OC-192(10Gbps) and OC-468(40Gbps)

57 Direct Connections

SONET:Synchronous Optical Network

OC-1 = 51.8 Mbps = 1DS-3, 28DS-1, 672DS-0

OC-3 = 155.52 Mbps. DS-0 = 64 Kbps (8000 samples/sec*8bits/sample)

OC-9 = 466.00 Mbps

OC-12 = 622.00 Mbps

OC-18 = 933.00 Mbps

DS-1 = 1.544Mbps = 1T1

DS-3 = 44.7 Mbps

DS: Digital Signal (Asynchronous)

OC-24 = 1.244 Gbps

OC-36 = 1.866 Gbps

OC-48 = 2.488 Gbps

OC-96 = 4.976 Gbps

OC-192 = 9.953 Gbps

OC-768 = 40.00 Gbps

SONET:Synchronous Optical Network

SONET Frame: OC-1 Structure

[(9 Rows /Frame)*(90 Octets/Row)*(8 bits/Octet)*
(8000 Frames/Sec.)] = 51.8 Mbps.

(Sample rate for OC-1 = 8000 Frames/Sec)

Abilene Characteristics Continued

Currently 225 Participants

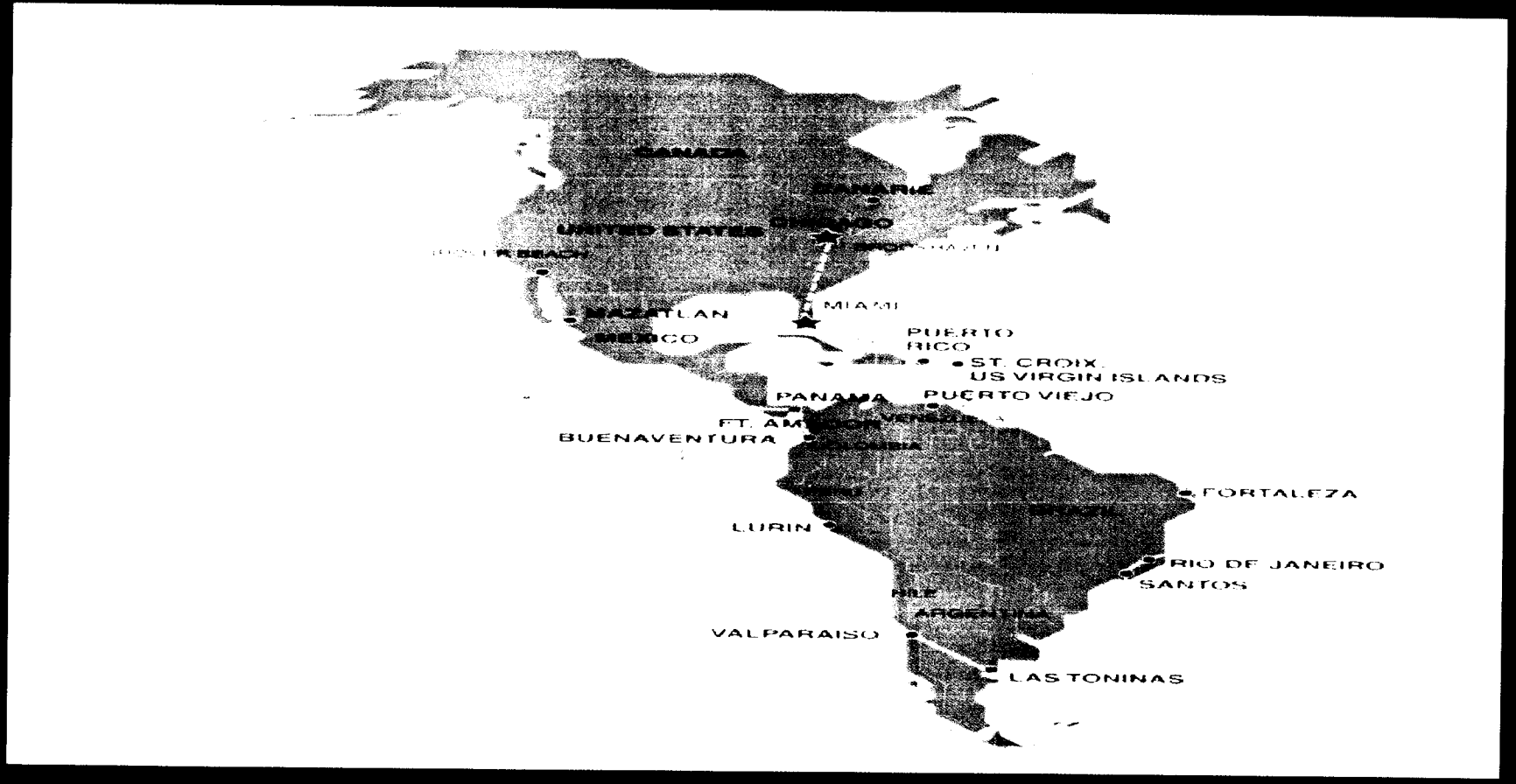
- All 50 States, District of Columbia, & Puerto Rico
- 15 Regional GigaPops support 70% of the participants
- 50 sponsored participants

Abilene Characteristics Continued

Transoceanic

- STARTAP STAR LIGHT –Chicago
- PACIFIC WAVE – Seattle
- AMPATH – Miami
- New York

AMPATH CHART



Abilene Costs

OC-3 (155-Mbps)	$110,000/yr.
OC-12 (622–Mbps) SONET	$270,000/yr.
OC-48 (2.4 Gbps) SONET	$430,000/yr.

Other Costs:

UCAID $25,000/yr.+Abilene Fee $20,000/yr.

+QWEST Fee $1,000-$3,000/mo.+Local Loop Fees

Failure Classification for Abilene Backbone Network

Router Problems

- -Overload
- -Reload
- -Instability
- -Configuration
- -IOS code

-Router Problems

-Packet loss
-Processor
-Loss of power
-Routing latency
-Cisco IOS bugs
-Excessive route advertising

-Border Gate Protocol (BGP) Problems

-Loss of BGP connectivity
-BGP instability
-Sporadic BGP resets
-Intermittent BGP connectivity

-Peering instability Problems

-Loss of connectivity
-Trouble with circuit provider
-I2-commodity route leak
-Flooding at client site

-Multicast Problems

-Inability to receive multicast sources

Other Problems include the following:

-OC-48 single mode errors
-Bad OC-3 module, bad OC-12 card
-Session flapping
-Loose fiber connection, Loose Cabling
-Adjacency entry errors
-CRC errors
-Bad throughput
-Unable to login
-Connector outage
-Core mode unreachable

Future

Multicasting – will allow broadcasts to multiple users at same time

IPv6 – will allow address space to go from 32 to 128 bits. This will allow a dramatic increase in pool size and enhanced security.

Summary of Internet 2

To create a world-leading, high performance network infrastructure for education & research community

To enable revolutionary Internet applications

To ensure the rapid transfer of new network service & applications to the broader Internet community

Conclusion

We may be already 5 years behind